Subducted Eurasian plate beneath Taiwan:

Evidences from slab guided waves and strong motion data

尋找馬尼拉隱沒帶之蹤跡?

導波特性 與 強地動異常之關係

Student name: Yu-Lung Tseng

Supervisor: Kate Huihsuan Chen

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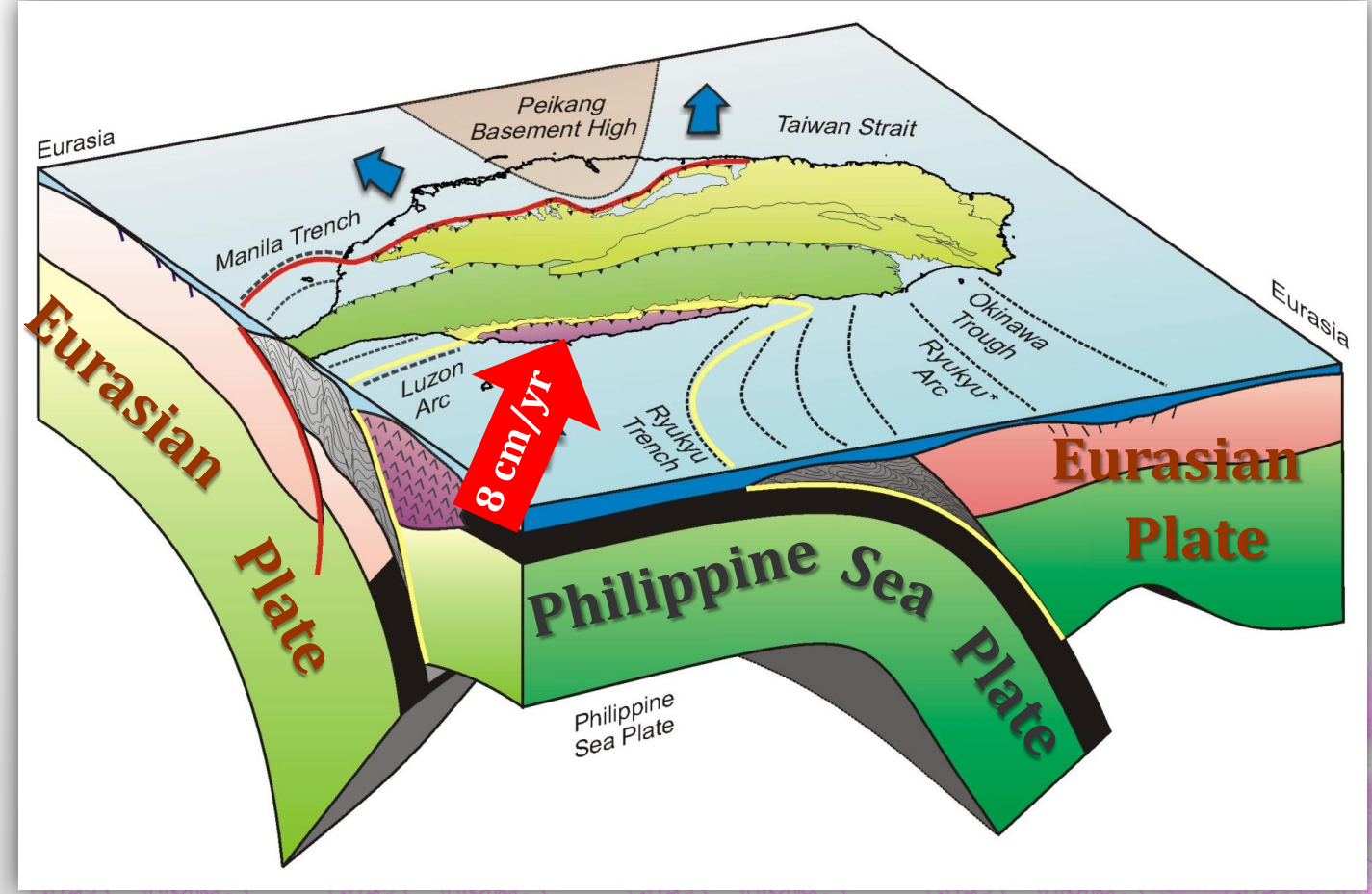
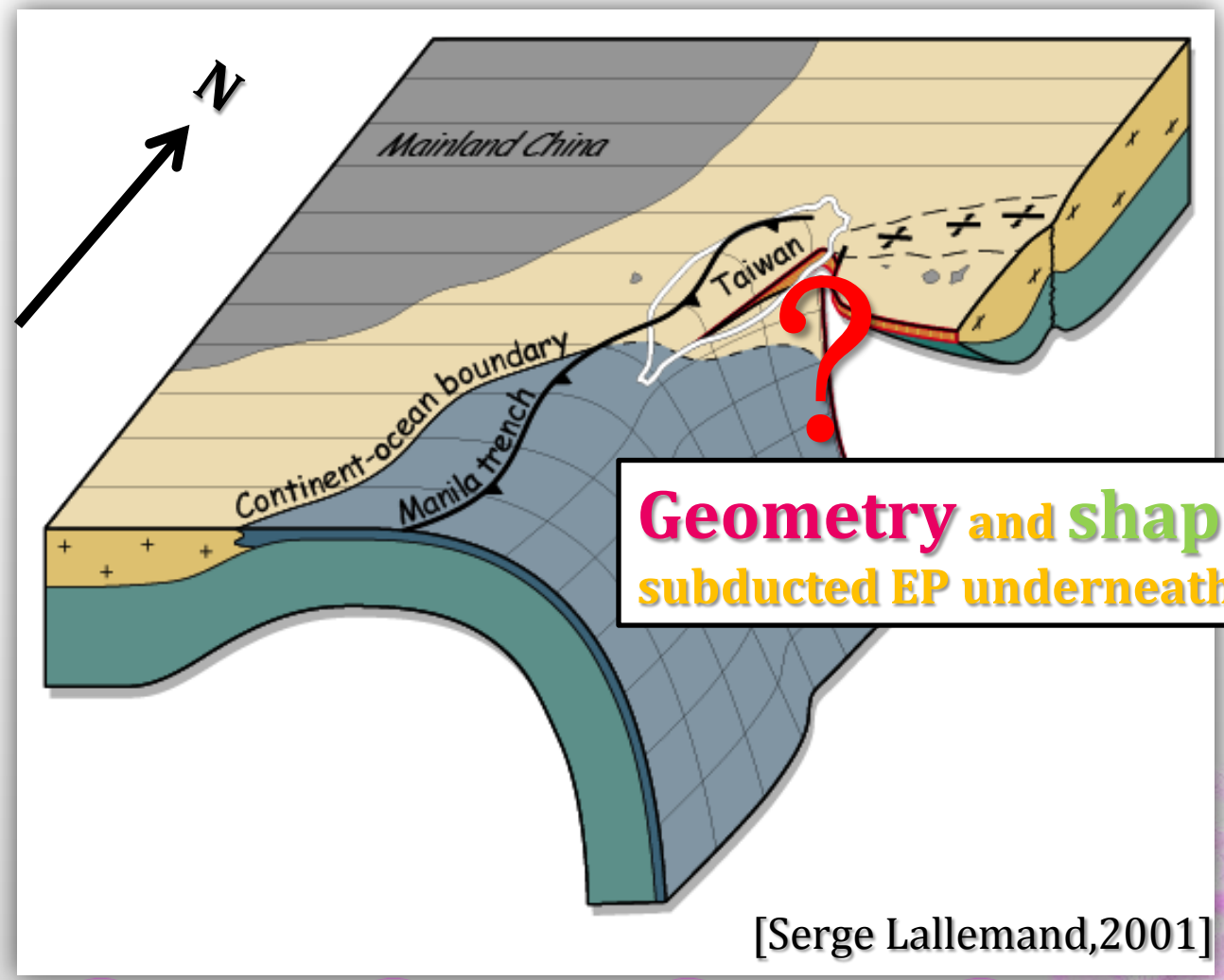
Subduction zones near Taiwan

Taiwan is located at the boundary between the Philippine Sea Plate (PSP) to the east and the Eurasian Plate (EP) to the west, with a convergence rate of ~ 80 mm/yr in a N62 ° W direction



The interaction between the two plates is still unclear



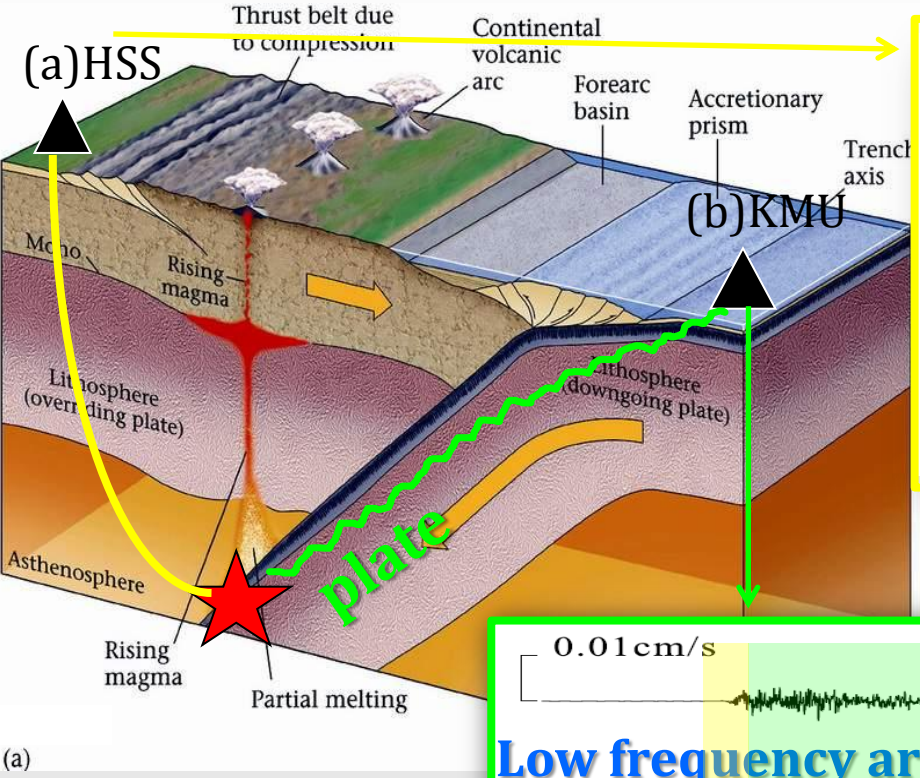
What we want to see?

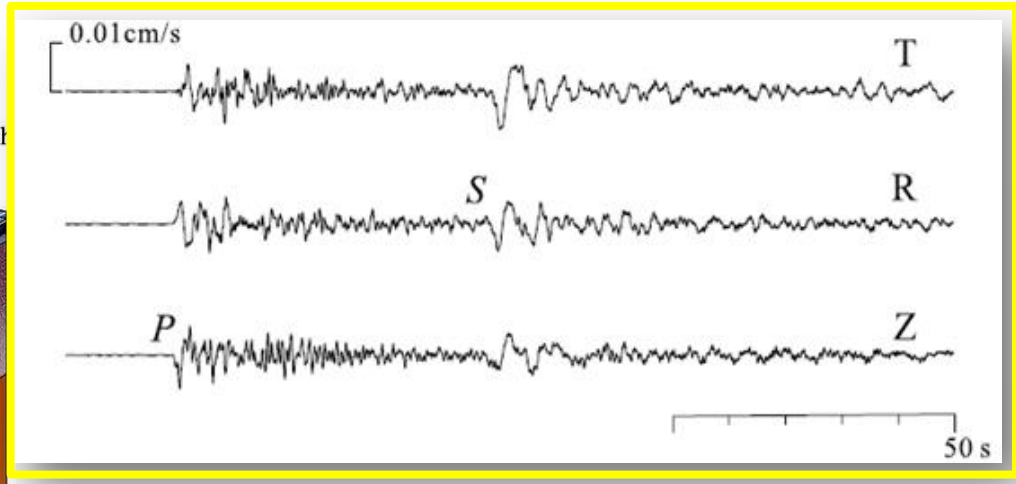
the extension of EP underneath Taiwan

using a special seismic phenomenon

subduction zone guided waves

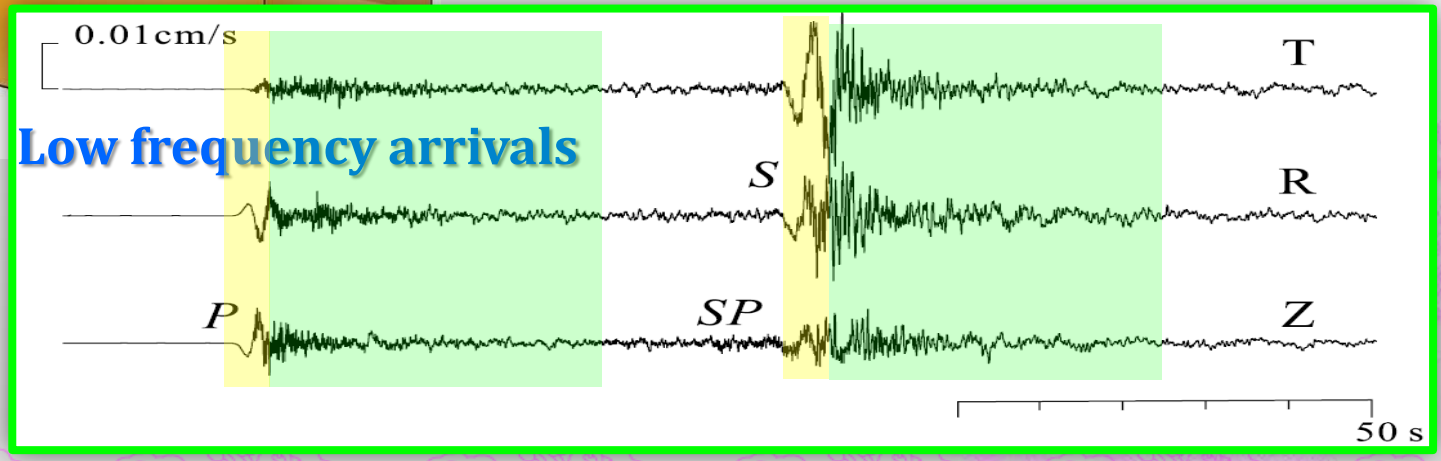
Earthquakes near subduction zone radiate complex wave field



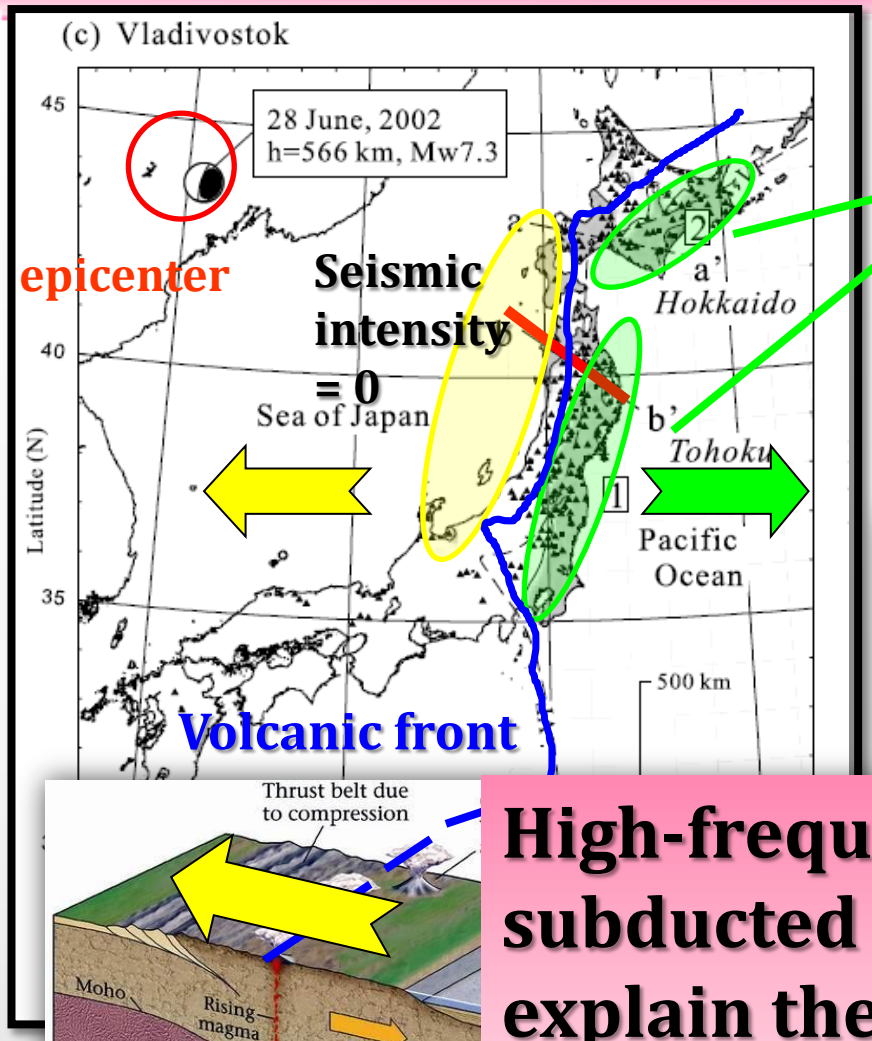


[Furumura and Kennett, 2005]

High frequency with long coda



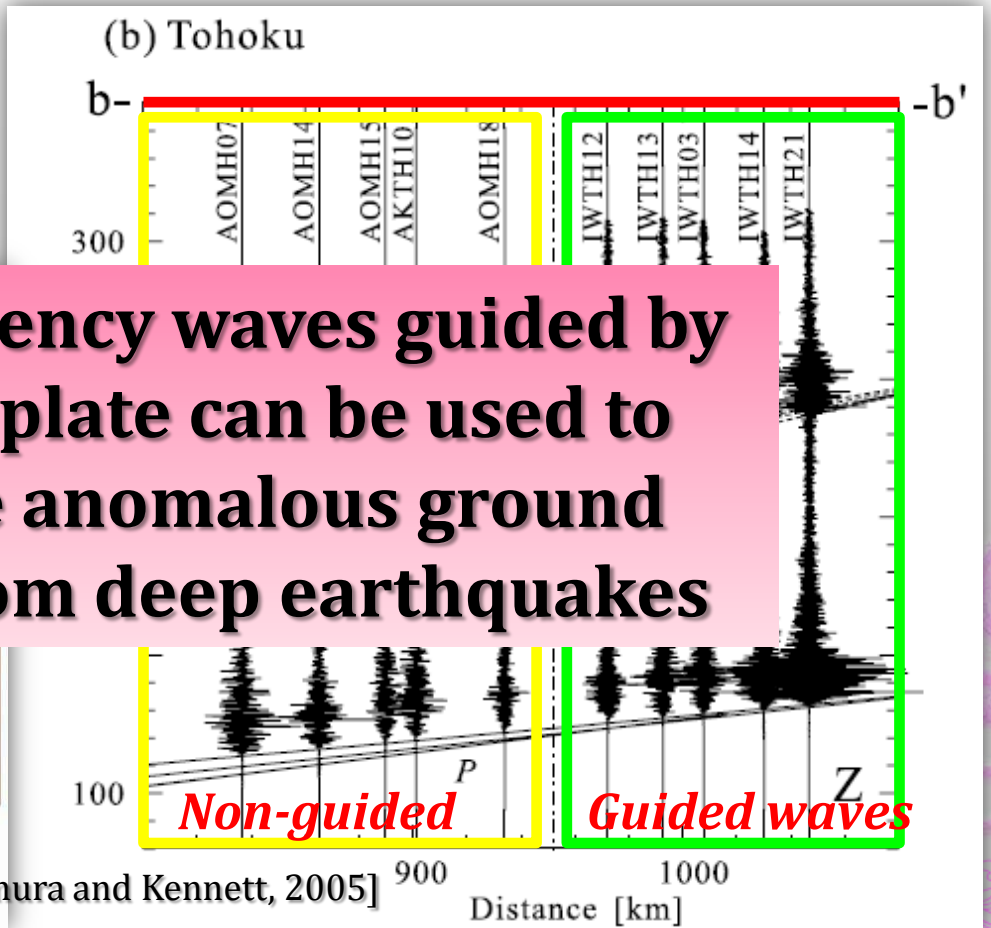
Guided waves

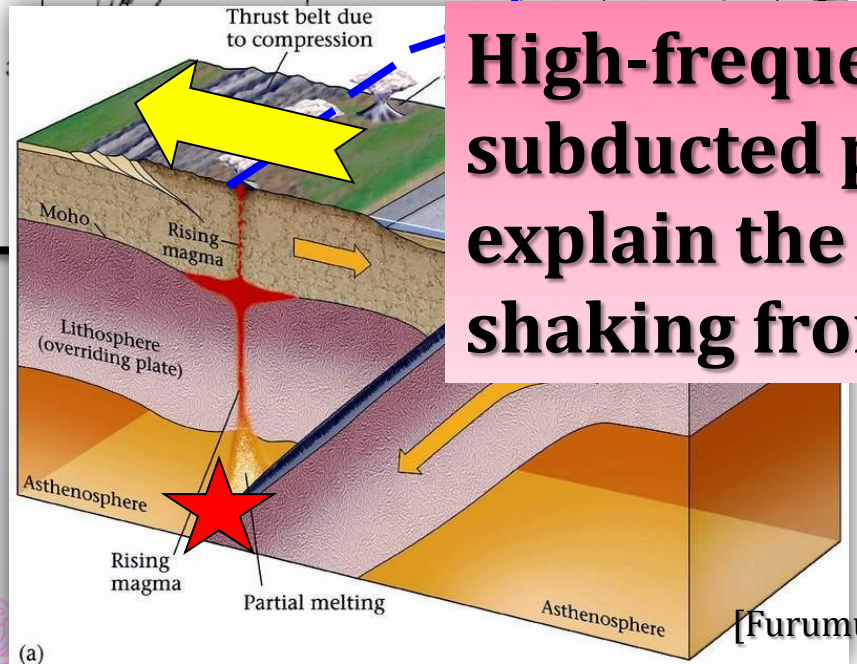


Large intensity in fore arc area

Seismic intensity = 1 or 2

back arc station *fore arc station*



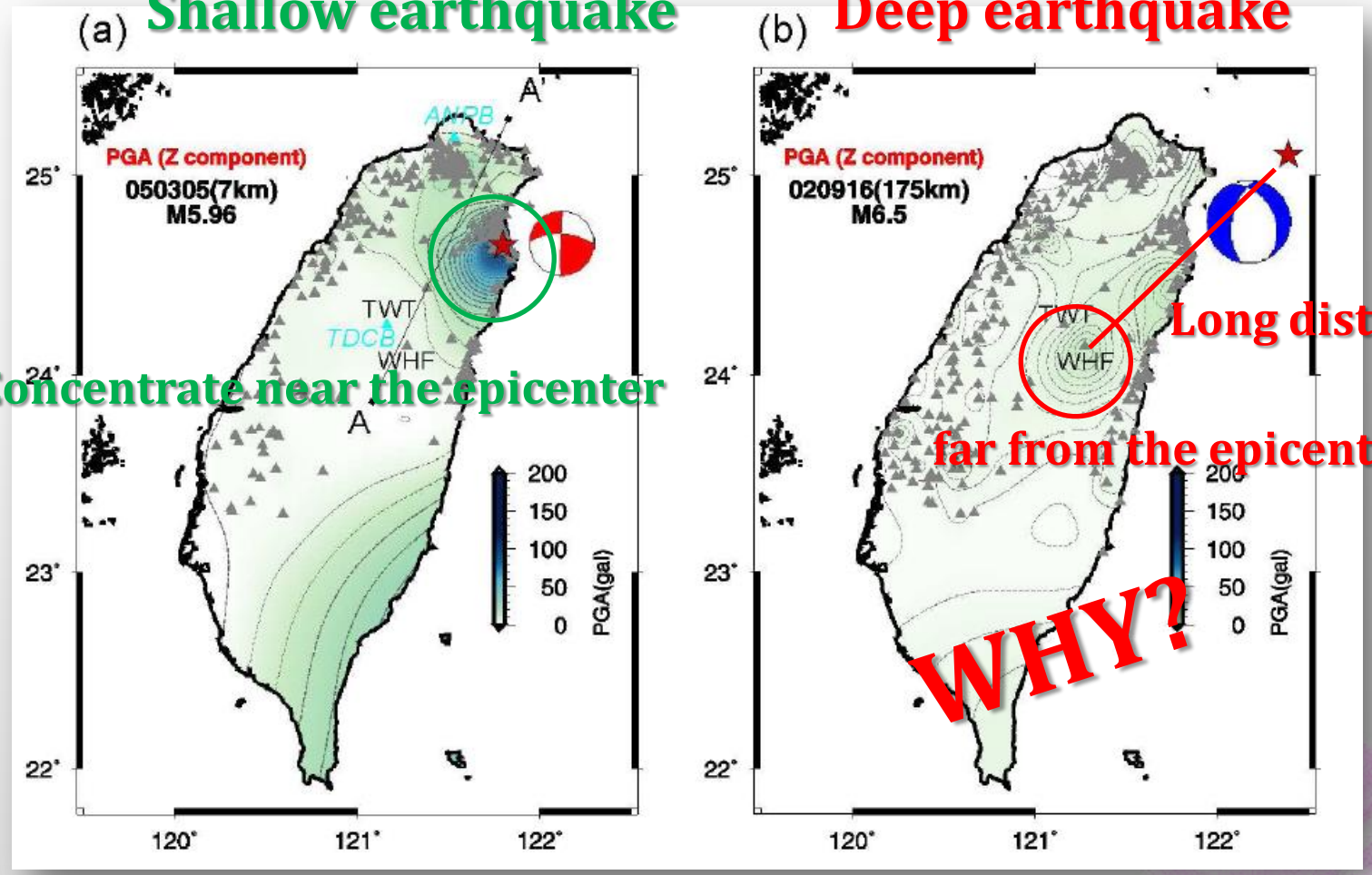


High-frequency waves guided by subducted plate can be used to explain the anomalous ground shaking from deep earthquakes

[Furumura and Kennett, 2005]

Guided waves produced by PSP

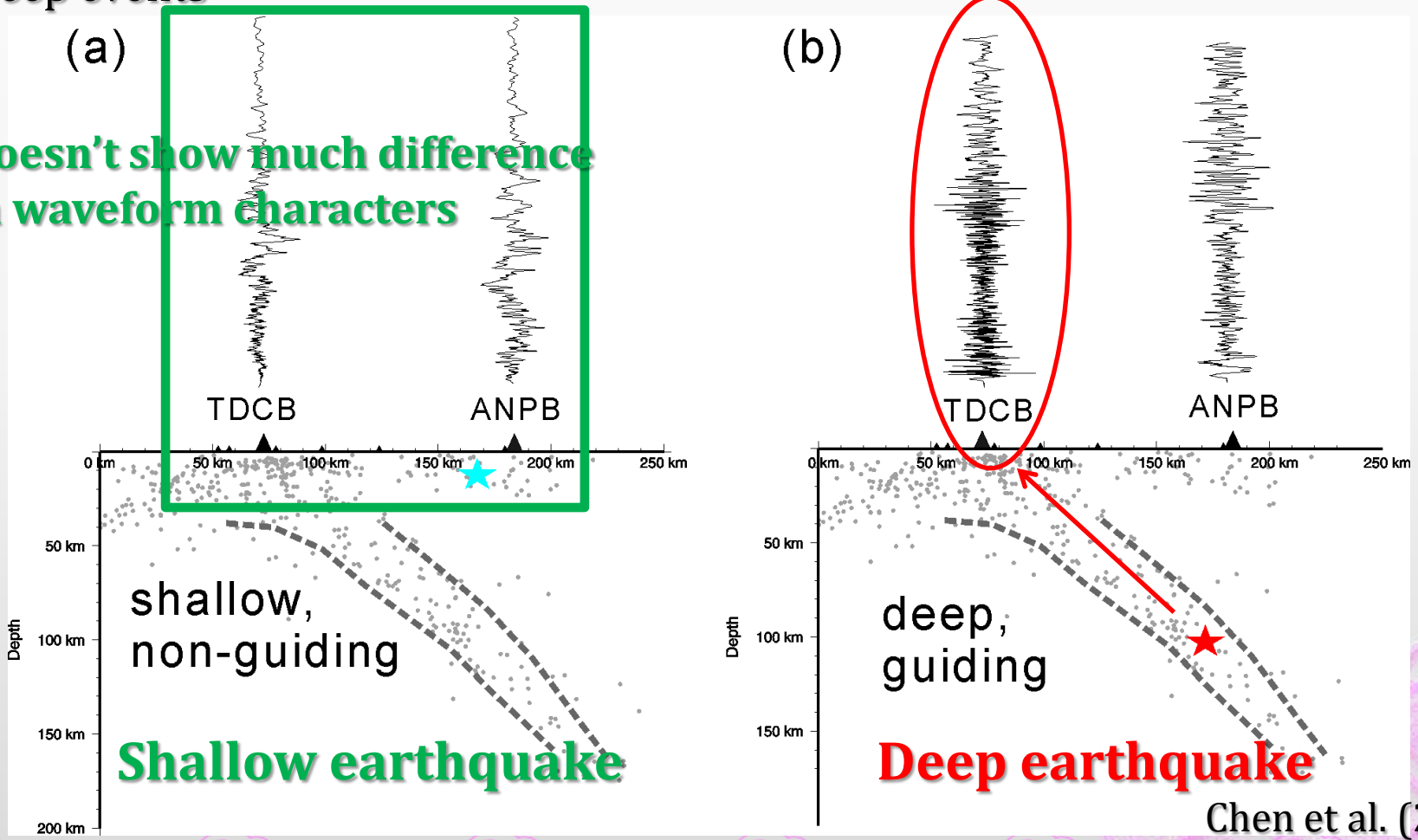
1.anomalous seismic intensity (PGA)



Chen et al. (2010)

2. high frequency with long-duration guided wave

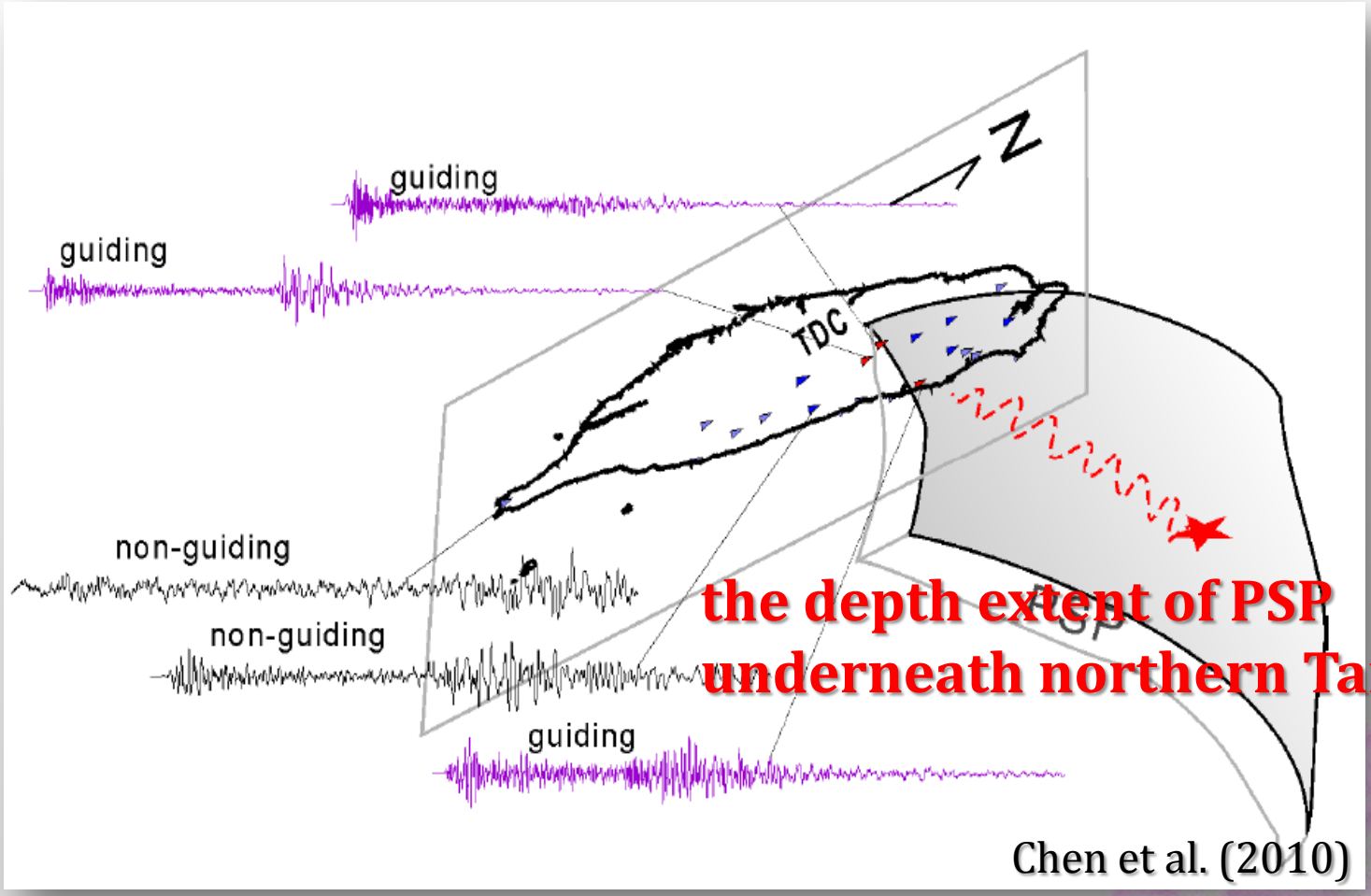
A clear difference in the waveforms appears between the shallow and deep events



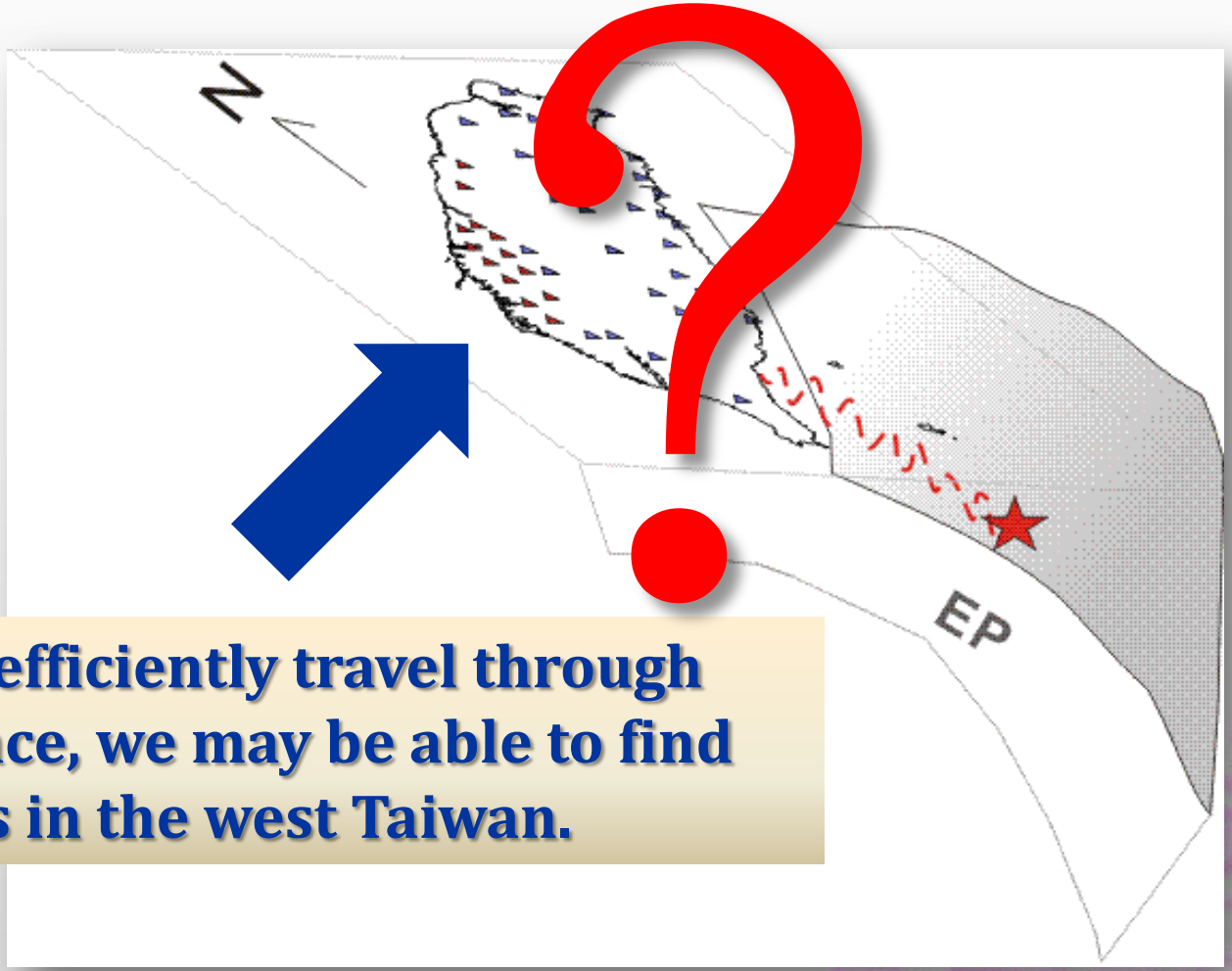
Chen et al. (2010)

Stations with guided waves effect

It suggests that seismic waves travel along the subducted slab can excite the high frequency signals with long duration coda



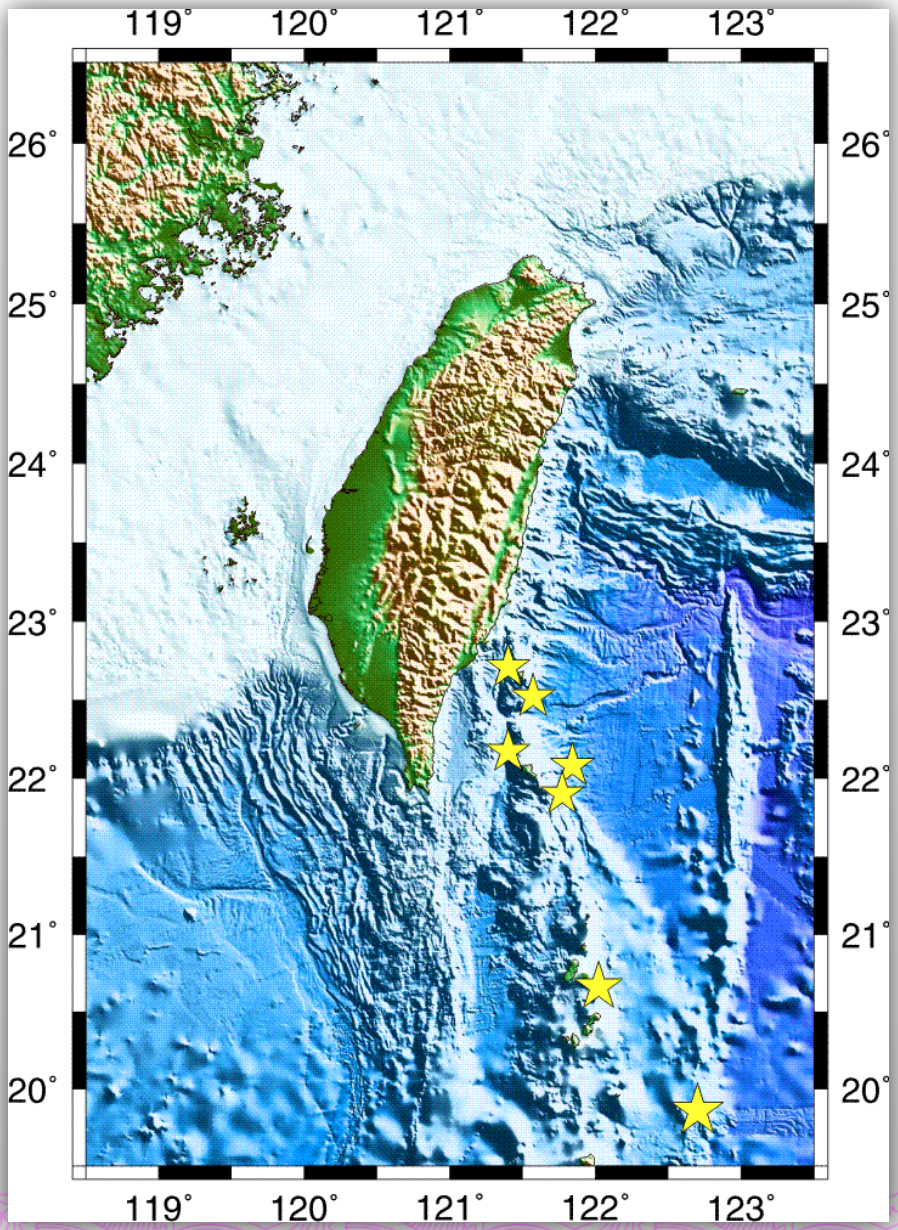
Can we find the guided waves from the subducted Eurasian plate in southern Taiwan?



If seismic waves efficiently travel through the plate to surface, we may be able to find the guided waves in the west Taiwan.

Data

Deep earthquakes in SE Taiwan offshore



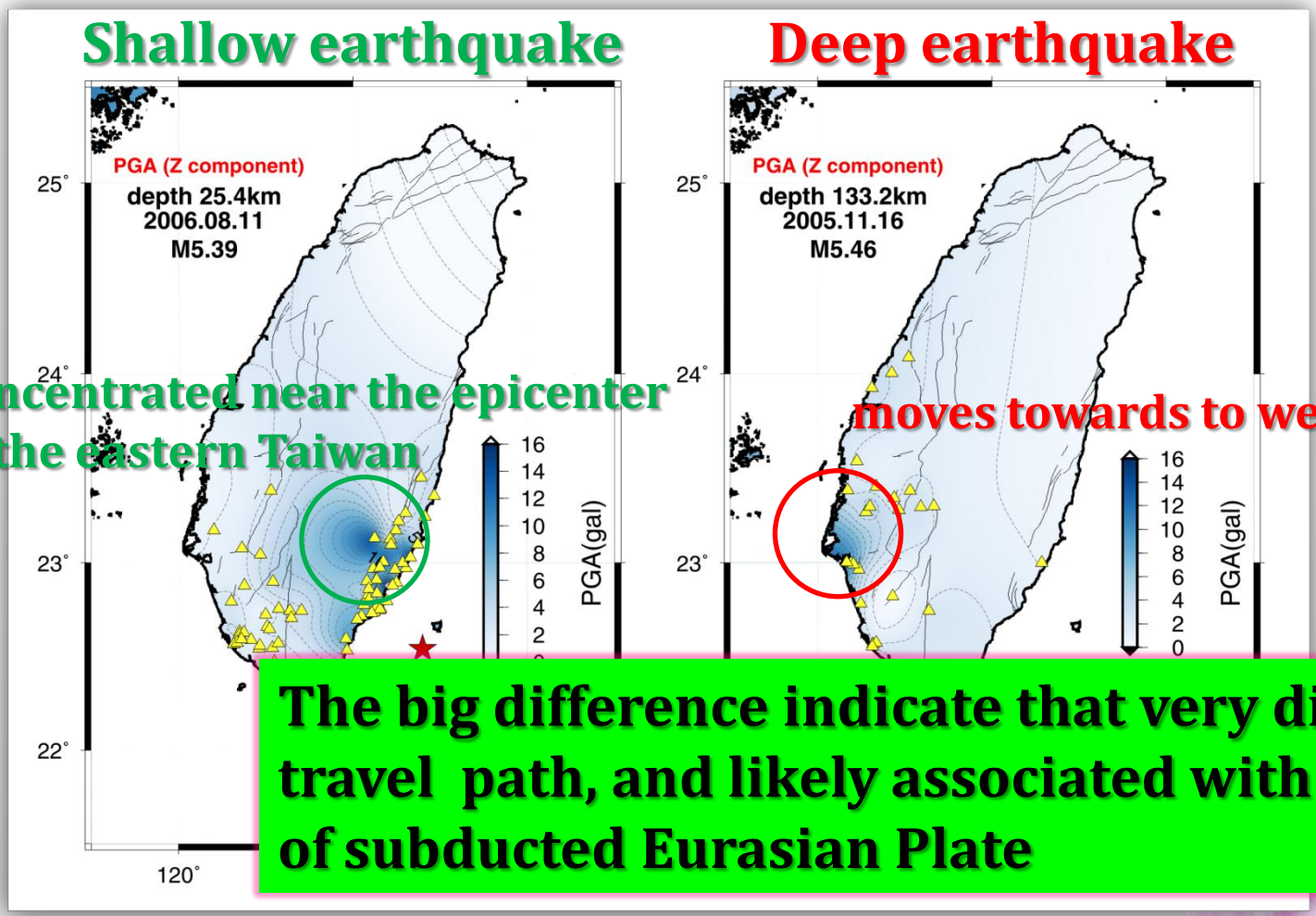
Study period : 1990~2009
Magnitude (M_L) : larger than 5
Depth: deeper than 80km

Table

Occur date (UTC)	Depth (km)	Magnitude M_L
1993/05/18	188.59	7.12
1993/11/12	184.65	5.88
1994/10/14	124.45	5.65
1998/03/08	173.72	6.05
1999/05/18	84.34	5.51
2003/09/10	85.36	5.76
2005/11/16	133.2	5.46

Anomalous distribution in PGA patterns

PGA

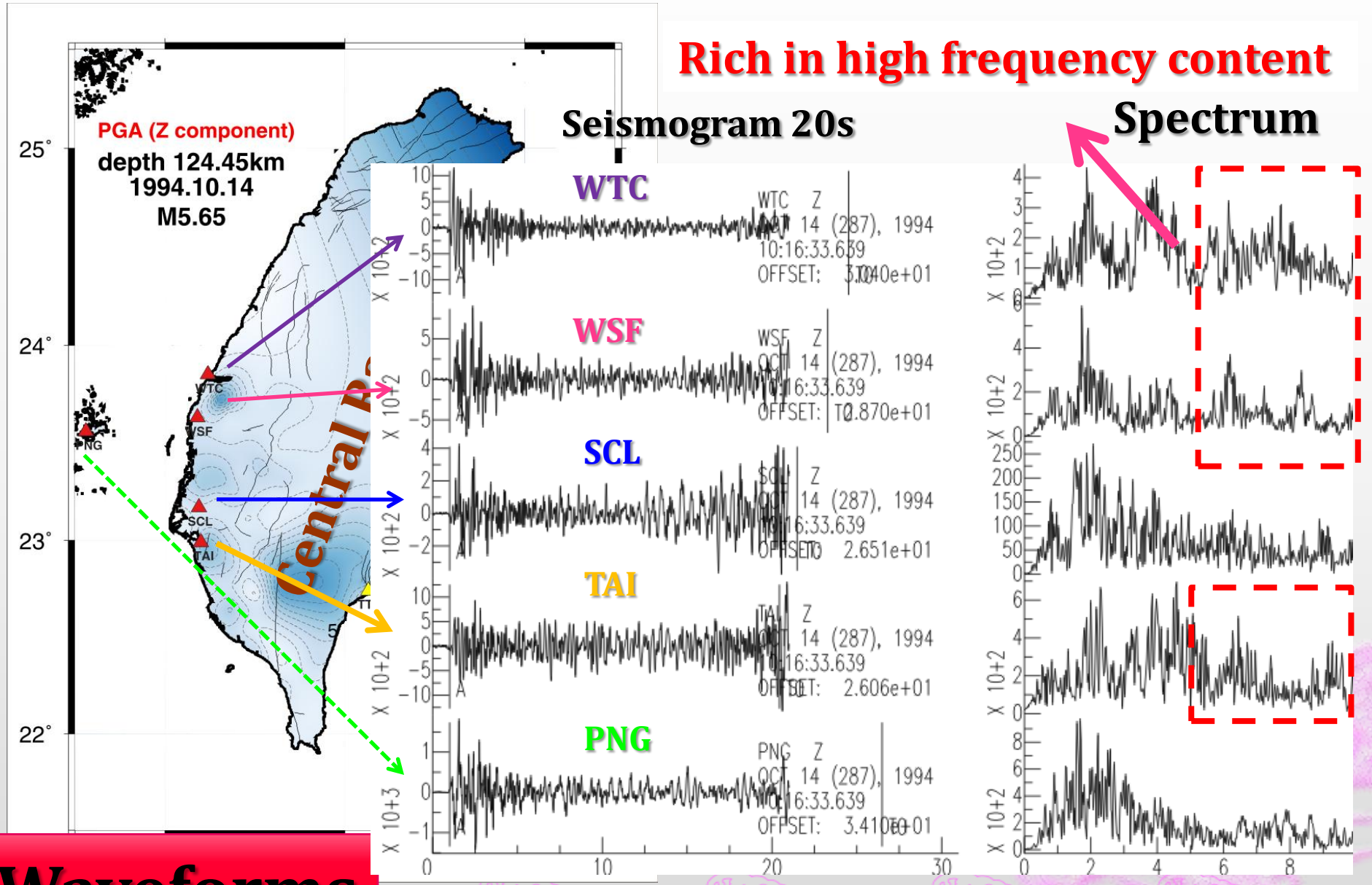


Concentrated near the epicenter in the eastern Taiwan

moves towards to western Taiwan

The big difference indicate that very different travel path, and likely associated with the role of subducted Eurasian Plate

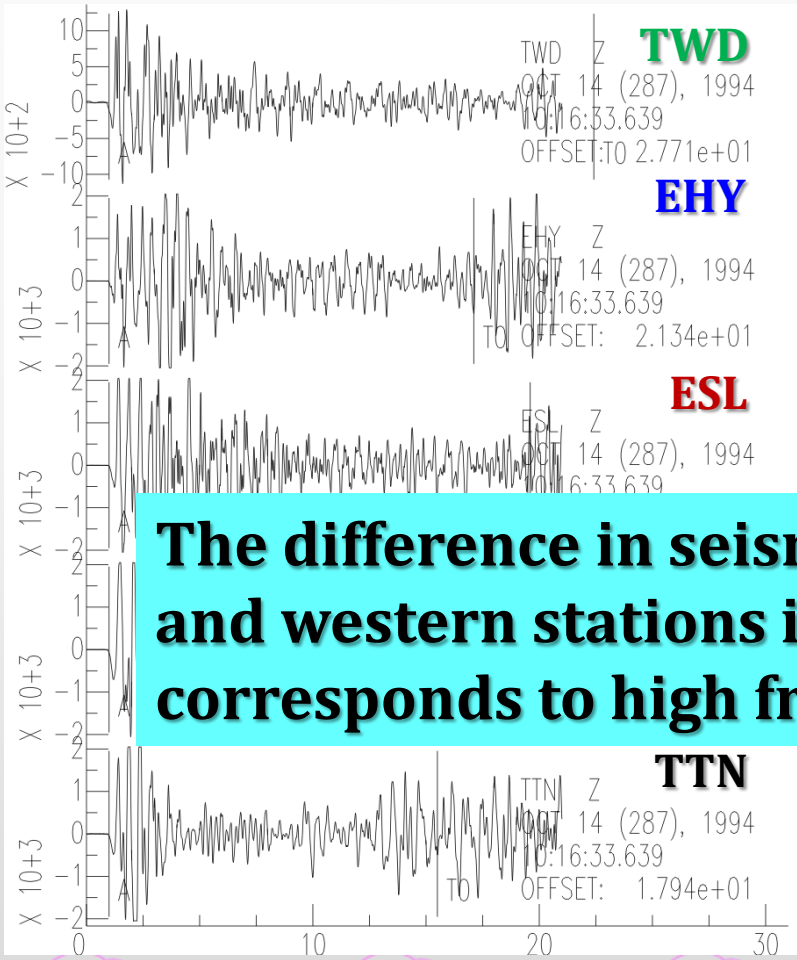
a. Seismic characters in the west of Central Range

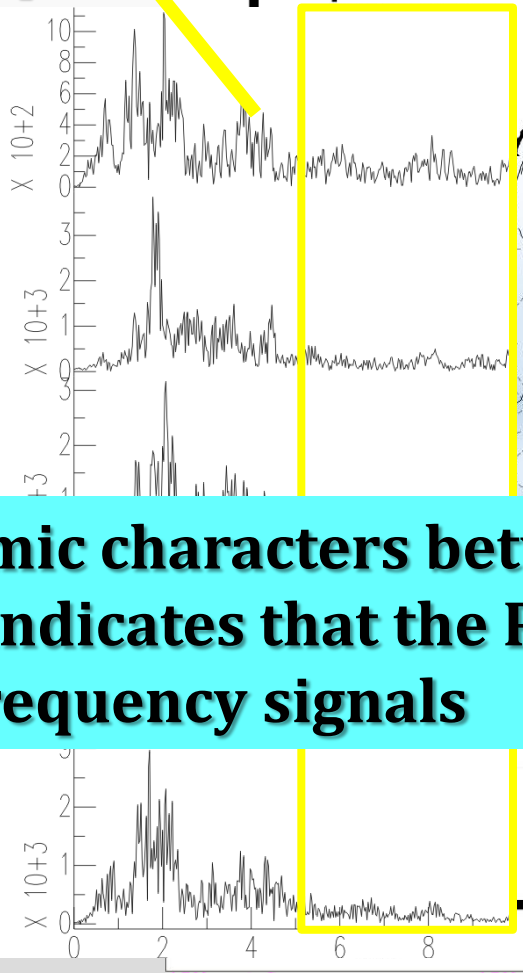


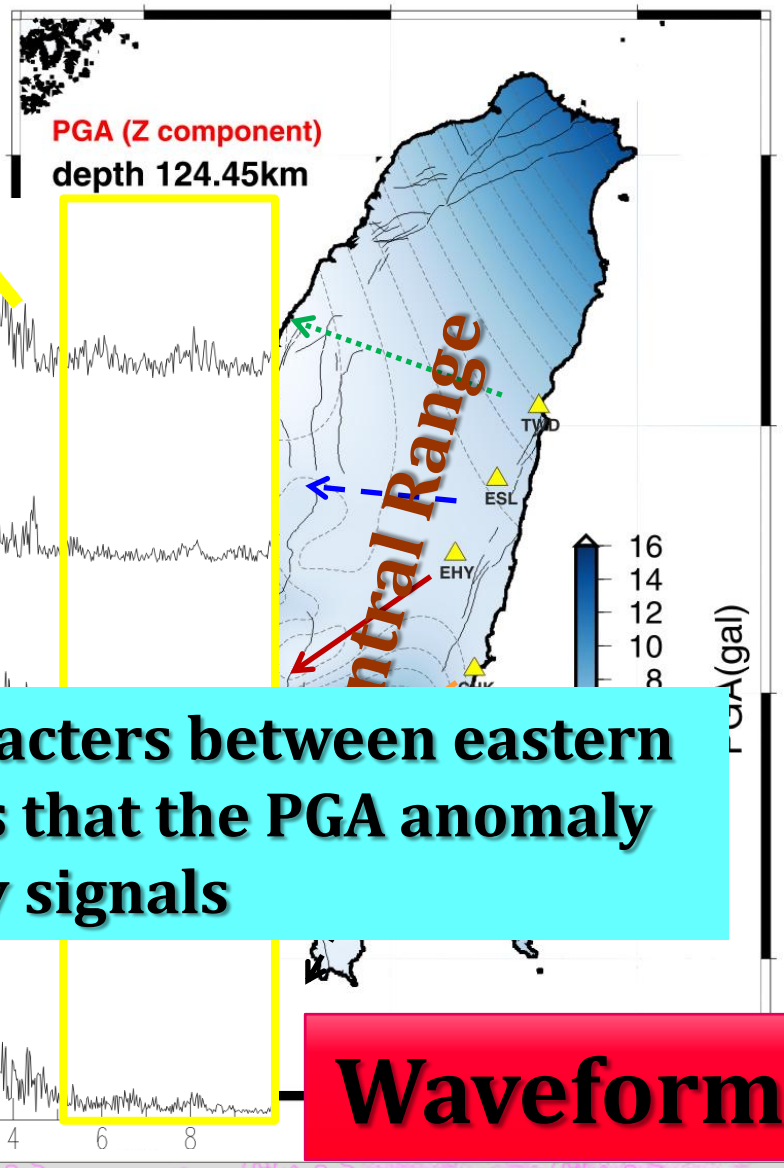
Waveforms

b. Seismic characters in the east of Central Range

Much less high-frequency content





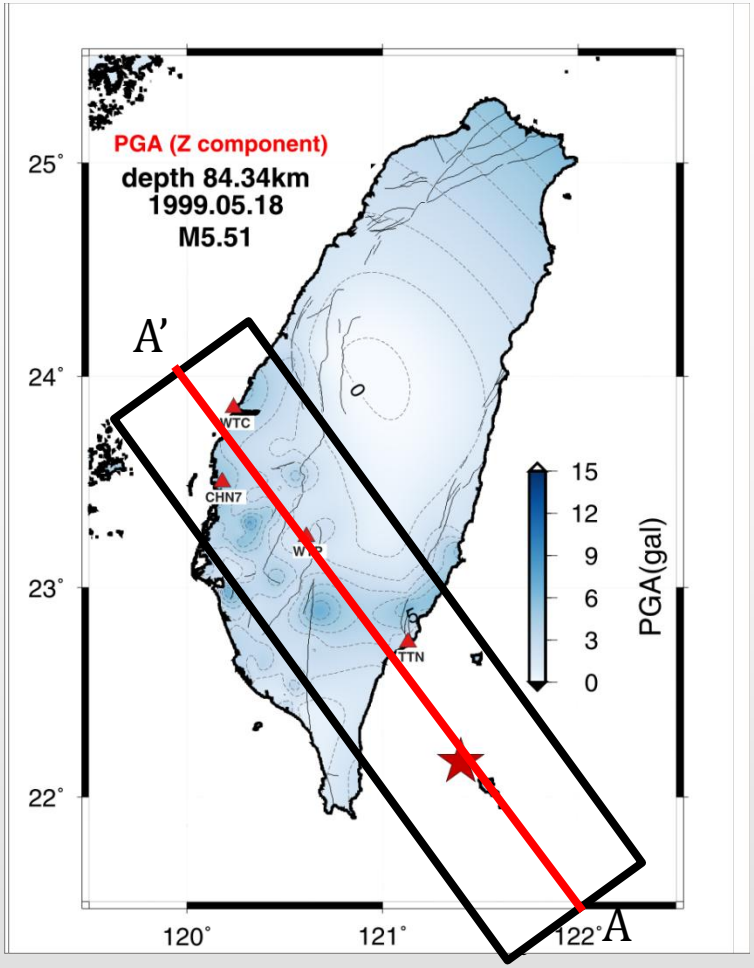


The difference in seismic characters between eastern and western stations indicates that the PGA anomaly corresponds to high frequency signals

Waveforms

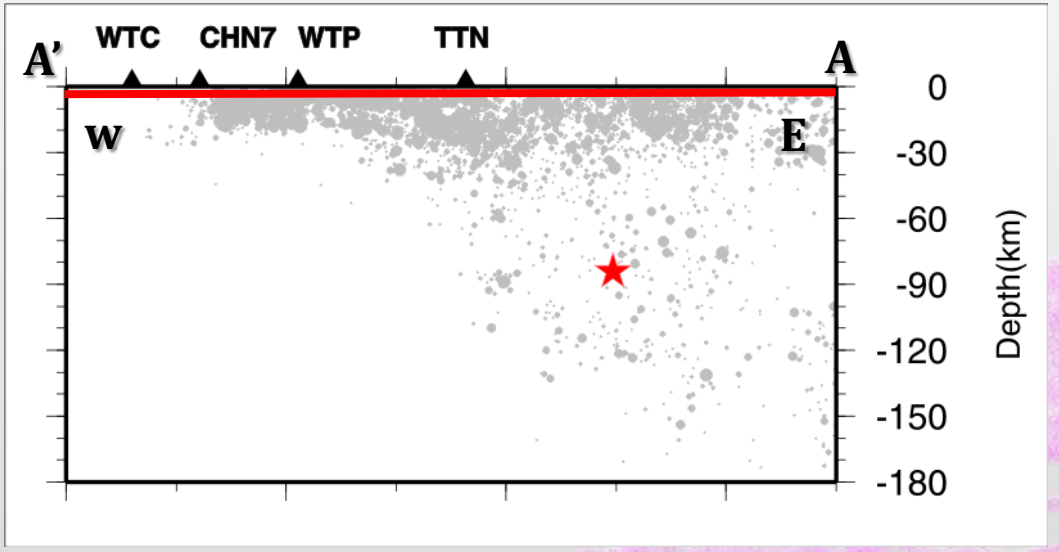
Cross-section for the different seismic characters

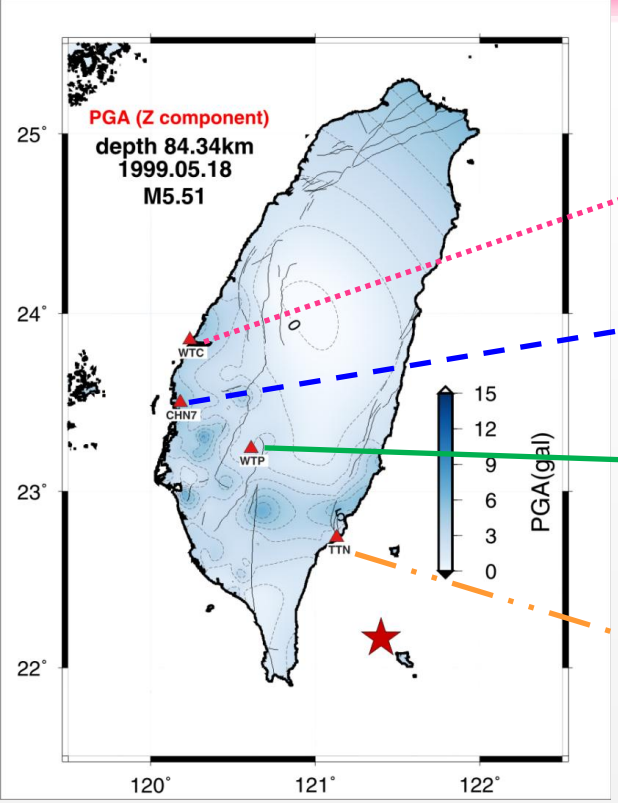
Cross section



A-A' : (120, 24) ~ (122,21.5)

Width : 100 km



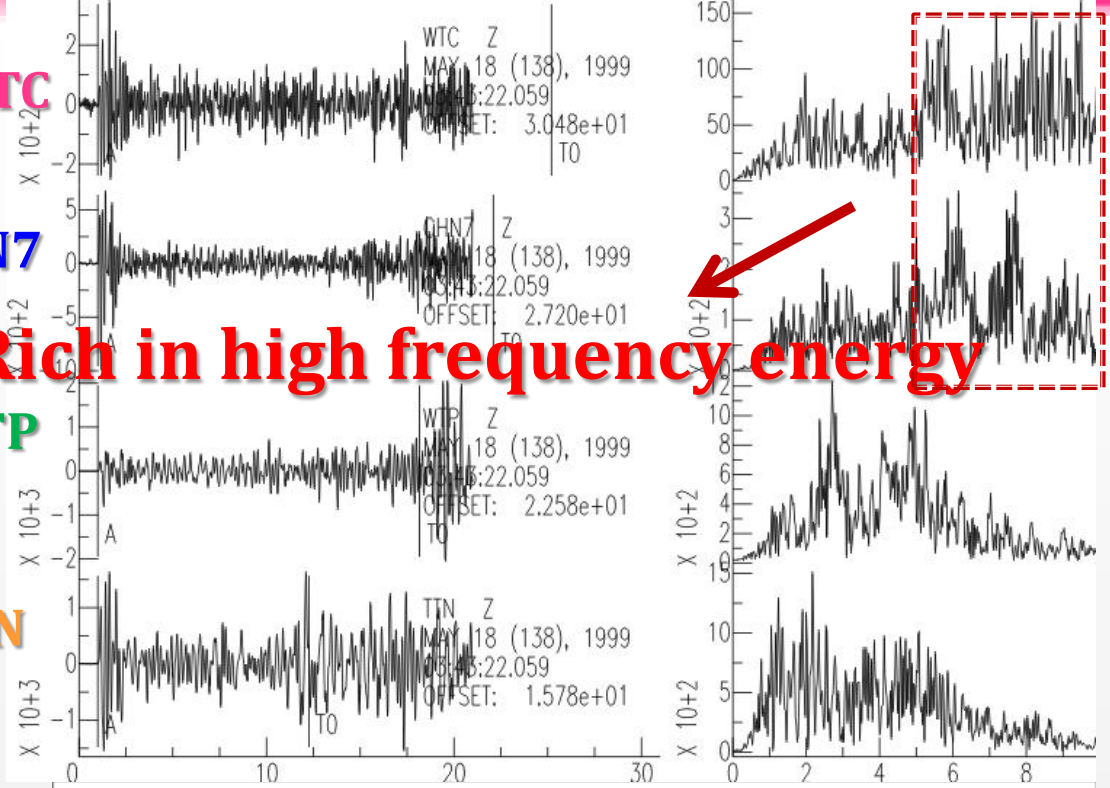


WTC

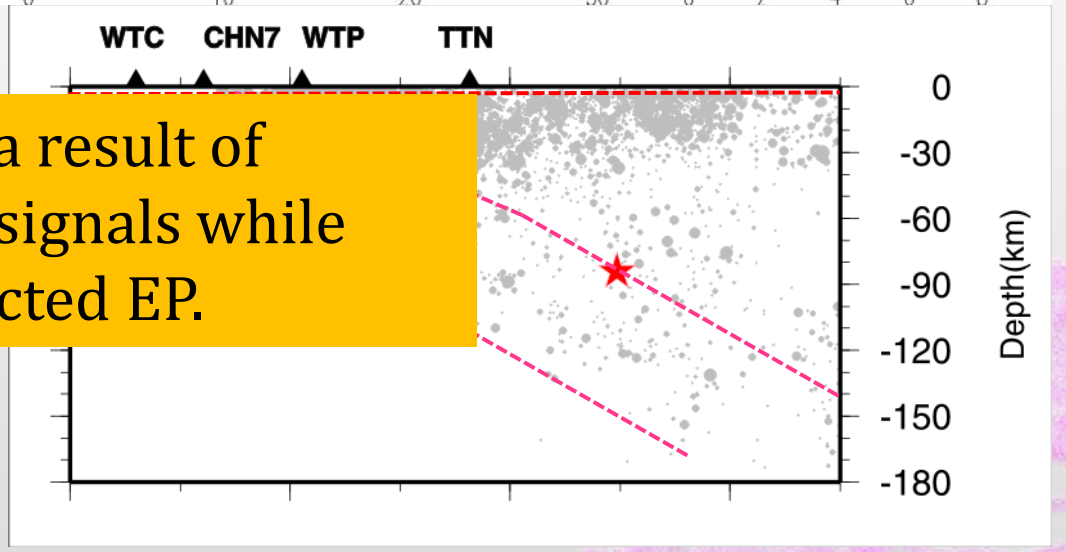
CHN7

WTP

TTN



Rich in high frequency energy



Guided waves event is likely a result of excitation of high-frequency signals while propagating along the subducted EP.

Summary

In this study, we demonstrate the evidences of subducted EP underneath Taiwan and investigate the possible relationship between these evidences.

Peak Ground Acceleration (PGA):

- Deeper events (>80km) from the south offshore reveal distinct patterns compared with shallow events (~10km).
- The PGA anomaly appears in the west Central Range.

Seismic wave characters:

- Deeper events reveal the trapping effect of the high frequency signal, but the shallow events do not.

The good spatial correlation between the strong PGA and guided effect implies that a partial guiding across the southern portion of Taiwan carrying a modest amount of high frequency energy and a slow decay of coda, that explains the PGA anomaly.

The guided waves observation provides critical inputs to connecting with the seismic intensity anomalies for ground motion and earthquake hazard estimation.

Reference

- T. Furumura & B.L.N. Kennet 2005 : Subduction zone guided waves and the heterogeneity structure of subducted plate : Intensity anomalies in northern Japan
- Kate Huihsuan Chen & Fred Hua & Brian Kennett 2010： Observation of guided waves in the Ryukyu subduction zone
- Serge Lallemand & Yvonne Font & Harmen Bijwaard & Honn Kao 2001 :New insights on 3-D plates interaction near Taiwan from tomography and tectonic implications
- S. Martin & A. Rietbrock 2006 : Guided waves at subduction zones : dependencies on slab geometry, receiver locations and earthquake sources

Thank you for your Listening